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DETERMINANTS OF SICKNESS IN MARINE RECRUITS: A REPLICATION

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DETERMINANTS OF SICKNESS IN MARINE RECRUITS: A REPLICATION,

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SUMMARY

Previous research had shown that platoons in Marine Corps basic training had different illness rates. Further, high rates of illness in one diagnostic category were correlated with high rates in another diagnostic category. The data also indicated that platoon differences became more pronounced during the course of training. These facts led to the suggestion that a general factor, such as an emergent social climate within platoons, might be influencing illness rates. As part of a program investigating the effects of stress on recruits, an attempt was made to replicate these findings while correcting possible methodological influences on the results from the earlier study. If the results could be replicated, stress differences could be investigated as a possible contributing factor to platoon illness rate differences.

Method

The health records of recruits were examined in two samples of platoons. For each illness incident, the date of initial dispensary visit, diagnosis, number of visits, and disposition were recorded. Diagnoses were grouped into upper respiratory infection, trauma/injury, and "other" categories. The training cycle was divided into five periods reflecting different types of primary training activity and the illness data expressed "per 1000 man days" for each period. Analysis of variance was used to determine the effect of platoon, period of training, and type of illness on overall incidence rate. Correlations were used to determine whether the illness incidence rates in different diagnostic categories were related. Correlations were also used to determine whether a platoon with a high incidence rate in a given diagnostic category during one period of training also tended to have high rates in that category in other periods.

Results

(1) Platoon, period of training, type of illness, and a platoon by period of training interaction all contributed significantly to illness incidence rates. (2) The highest illness rates for all types of illness were observed during the first and last training periods. (3) Platoon differences in illness rates accounted for about 9 percent of the total variation in illness incidence. (4) Illness incidence rates for different types of illness tended to be positively correlated over the full training cycle due primarily to correlations occurring during the later training periods. (5) Platoons that had a high rate of incidence for a given diagnostic category during one period of training did not tend to have high rates for the same category in other periods.

Implications

The data provided a reasonable replication of the findings from the previous study of basic training illness, but more detailed examination of the data trends suggested a modification of the conclusions from the earlier study. Platoon differences in illness incidence rates were observed, but the effect of social climate or some other general factor on these rates may be confined primarily to specific periods of training. During other training periods, task demands and other factors such as exposure to new pathogens may be the primary determinants of illness. If these suggestions are correct, illness incidence might be reduced during some parts of training by stressing particular aspects of leadership. In other periods, illness incidence could potentially be altered by changing the task structuring and the distribution of tasks across the training cycle.

INTRODUCTION

Illness, particularly mild infectious disease and minor trauma, is common in military basic training. This fact, coupled with the standardization of important elements of day-to-day living, makes basic training a useful setting for some types of epidemiological investigation. Stewart and his colleagues (1) capitalized on this situation to investigate the following question: "Is the human environment, as expressed by social and cultural attributes of defined groups, a more potent determinant of sickness than the conventionally attributed single causes like microorganisms, individual disposition and proneness to accident or exposure to risk?" (1, p. 254). Specific hypotheses were:

> "Under the single-cause-single-effect hypothesis, differences in amount of sickness between platoons are explained by introductions of infectious diseases or by differences in the drill procedure leading to differential sickness rates of the musculoskeletal and trauma complaint type. Thus, this hypothesis predicts that in a given platoon a high sickness rate of one complaint type is unlikely to be accompanied by a high rate of another complaint type, unless the two single causes involved both happen to act excessively on the same platoon. Likewise, the hypothesis predicts that the time of peak sick call incidence for one complaint type is unlikely to coincide with the time of peak incidence for another complaint type. The alternative hypothesis--that the cause of increase of a sickness in a recruit group is largely nonspecific--predicts an association between the sick call rates of various complaint types in the same platoon, and a similarity of training stages having peak sick call incidences of the various complaint types. A similar reasoning holds for the time of peak incidence of sickness comparing one platoon with another." (1, p. 254)

Stewart, et al. (1) concluded that a general factor did affect illness in basic training. One basis for this conclusion was the presence of significant platoon differences in sick call visits. Also, these differences became increasingly significant over the course of training as would be expected if the general social climate of a platoon was an emergent characteristic or had cumulative effects. As predicted from the nonspecific cause hypothesis, sick call rates for one type of illness correlated with sick call rates for other types of illness. Finally, interactions between type of illness, platoon, and period of training accounted for little of the overall variance. Strong interactions were assumed to follow from the single-cause-single-effect hypothesis.

The conclusion that a general factor was important to health in basic training has important implications for epidemiological models of illness and health behavior. The present studies were undertaken to replicate the prior findings, if possible, to clarify some ambiguities in that study and to extend the hypotheses to provide additional tests of the probable significance of a general factor in health in basic training.

Stewart, et al.'s (1) findings were somewhat ambiguous because their results may have been influenced by methodological factors, including: (a) Sick call frequency was the measure of health problems. This measure can be misleading as a guide to the incidence or prevalence of illness because multiple sick call visits may be made for a single illness incident. (b) The data concerning sick call attendance did not provide a diagnosis for approximately 45 percent of the sick calls. Key analyses therefore appear to have been based on a potentially biased sample of the overall data. (c) No attempt was made to correct for differences in platoon size. This variable may have been approximately equal for all platoons at the beginning of training, but losses during training vary across platoons (2). This variation could contribute to both platoon differences in total number of sick calls and to the trend toward more significant differences between platoons over the course of training.

The extension of the previous research focused on a pair of hypotheses based on the concept of an emergent social environment which influences illness. Such an environment was postulated by Stewart, et al. (1, p. 261). One implication is that differences between platoons should not only become more pronounced as training progresses, but they should also become stable attributes of the individual platoons. Therefore, correlations between illness rates in adjacent time periods later in training will be higher than those between adjacent time periods early in training. Second, if the emergent social climate has a general effect on all types of illness, correlations between illness

rates for different types of illness will increase with time. Stewart, et al. (1) showed a significant correlation for overall rates of trauma and other types of illness, but did not examine the temporal trend to this correlation.

Given the potential importance of the conclusions from the earlier study (1) and the points noted above, the present study attempted to replicate the initial findings in two samples of Marine Corps basic training platoons. Design factors incorporated to allow for some of the possible methodological influences on the results of the earlier study included (a) attempting to distinguish illness incidents from number of sick call visits, (b) obtaining a specific diagnosis for each illness incident, and (c) adjusting the data to take into account differences in platoon sizes.

METHOD

Sample

Health data were collected for two separate samples of Marine Corps basic training platoons. The first sample consisted of 35 platoons in 9 training "series," (i.e., a group of four platoons going through training at the same time) graduating in February and March, 1980. One platoon was lost from the study because its health records were not available for coding. The second sample consisted of 48 platoons in 12 training series graduating between June and August, 1980.

Health Data

Health data were obtained from records kept at the Marine Corps Recruit Depot Dispensary, San Diego. One-half of the health records were randomly sampled for each platoon studied. More extensive data collection was impossible within the time and manpower constraints of the study.

Each time a recruit attends a sick call, the following data are recorded: (a) Date. (b) Presenting complaint(s). (c) Diagnosis. (d) Plan of treatment, including disposition with regard to duty status. Dispositions may be full duty, light duty, bed rest, or hospitalization. For light duty and bed rest, the disposition is for a specific period of time (e.g., 24 hours).

The above information was extracted from the records in terms of "illness incidents." An "illness incident" was defined as one or more visits to the dispensary for a given set of symptoms. Multiple visits were considered part of a single incident if (a) similar presenting complaints and symptoms were reported for each visit and (b) no two consecutive visits were separated by as much as 7 days or (c) if the record contained an entry indicating that the visit was part of a chronic problem despite a lapse of more than 7 days since the last visit.

The information recorded for each illness incident was: (a) Date of initial visit. (b) Diagnosis. (c) Total number of visits. (d) Disposition. Because dispositions other than "full duty" were typically expressed in terms of a period of time (e.g., 24 hours light duty), the entry for an incident was the total time for each type of disposition. For example, a recruit might be assigned 2 days of bed rest followed by 3 days of light duty for a given incident. Length of hospitalization was recorded in instances where the exact length of the hospital stay could be determined.

Analysis Procedures

The health data was initially coded in terms of specific diagnoses. These were subsequently grouped into upper respiratory infections (URI), musculo-skeletal traumas or other physical injuries (traumas), and "other" illnesses. These groupings roughly paralleled classifications used by Stewart et al. (1) and were necessary because specific individual diagnoses tended to be rare.

Aggregate scores for number of URI, number of traumas, number of "other" illnesses, total sick calls, days assigned to light duty, days assigned bed rest, and days of hospitalization were computed for each platoon. Separate scores were computed for: (a) The first 17

days of training when recruits learned drill and basic military protocol. (b) Two weeks spent learning to fire the M-16 rifle. (c) One week spent on mess and maintenance duty. (d) One week spent learning basic combat skills and tactics combined with exceptional physical demands in terms of hiking and running. (e) Twenty-one days during which recruits prepared for and took final tests and went through administrative procedures preparatory to graduating. These periods represent times of qualitatively similar training experiences as perceived by the recruits (3). The periods do not correspond to those employed by Stewart, et al. (1), but direct correspondence was impossible because of changes in the structure of the training program.

All scores were computed as frequency per 1000 man days to allow for differences in platoon size. Illness incidents prior to training, after the 66th day of training, or for which a specific date of first visit could not be established were excluded from the computations. Early illnesses could not reasonably be thought to represent effects of experiences in training and it was sometimes necessary to gather the health data at the end of the 66th day of training to avoid interfering with standard administrative procedures in the training command. Incidents lacking an indication of first date of visit could not be reliably classified in terms of period of training and were omitted for this reason. All together, these omissions accounted for 6.4 percent of the total incidents in the first study and 3.8 percent in the second study.

Prior to analysis, the data were transformed by taking the square root of the observed scores to improve the normality of the score distributions. The log (n+1) transformation used by Stewart, et al. (1) was considered as a possible transformation, but gave less satisfactory results than the square root transformation.

Relationships between variables were determined by Pearson product-moment correlations and analysis of variance was used to determine the effects of platoon, illness type, and period of training on overall illness rates. All analyses were carried out using the Statistical Package for the Social Sciences (4).

The two samples of platoons were treated as independent replications for the analysis. Therefore, it was necessary to combine the results of two sets of analyses. The simplest approach, i.e., requiring an effect to be significant in both studies, would have been inappropriate because it is too conservative (5). Appropriate techniques for combining the results of two or more studies have been summarized by Rosenthal (6). Following his recommendation for combining the results of a small number of studies, three separate approaches were used to determine the combined probability levels--adding logarithms, adding probabilities, and adding weighted z-scores. Because the study involved repeated measures, standard significance levels would have to be cautiously interpreted (7). Therefore, the combinatorial procedures were applied twice for the ANOVA results. The first time was to the standard probabilities which are comparable to those reported by Stewart, et al. (1). The second time the computations employed probabilities which assumed that each ANOVA effect was based on 1 and n-1 degrees of freedom where n is the number of platoons in the sample. The resulting significance level sets an absolute lower limit to the significance of the effects (8). In the present case, this lower limit is likely to be highly conservative because the illness measures were not highly correlated within or across time periods. The reported significance levels determined by these combinatorial procedures are the least significant for the three approaches as applied to any given result.

RESULTS

Illness frequencies varied across the training periods (see Table 1). A "Platoon by Time by Illness" 3-way ANOVA indicated significant variation in illness incidence frequency due to Platoon, Time, Illness, and the interaction of Platoon and Time (see Table 2). Even using the most conservative significance tests, the effects of Platoon ($p<.001$), Time ($p<.001$), and Illness ($p<.001$) would be significant.

The Platoon by Time interaction was equivocal because the combined significance level was only $p<.130$ using the

Table 1

Frequency of Three Categories of Illness and Proportion of "Return to Full Duty" Incidents by Period of Training[a]

	Sample	1	2	3	4	5
Upper Respiratory Infection[b]	1	8.17	2.13	5.60	3.52	7.65
	2	6.90	6.09	9.99	2.32	5.75
Trauma[b]	1	11.60	3.33	8.95	7.69	13.00
	2	15.22	5.89	10.49	10.03	13.94
Other[b]	1	7.01	2.91	5.59	5.48	7.02
	2	8.94	4.92	9.60	3.07	9.78
Proportion Returned to Full Duty	1	.490	.494	.556	.400	.440
	2	.504	.579	.576	.388	.493

[a]See Method for definition of periods.

[b]Illness incidence expressed as number of incidents per 1000 man days.

Table 2

Results of Platoon by Time Period by Illness Analysis of Variance

	SS	df	MS	F	Signif. Level	% of Variance
Sample 1:						
Platoon (P)	123.11	34	3.62	2.73	<.0001	9.4
Time (T)	225.97	4	56.49	42.61	<.0001	17.2
Illness (I)	52.98	2	26.49	19.98	<.0001	4.0
PxT	446.64	136	3.28	2.47	<.0001	33.9
PxI	95.63	68	1.41	1.06	.3656	7.3
TxI	11.25	8	1.41	1.06	.3915	0.9
PxTxI	360.64	272	1.33			27.4
Sample 2:						
Platoon (P)	134.01	47	2.85	1.94	.0004	8.0
Time (T)	253.16	4	63.29	43.08	<.0001	15.0
Illness (I)	113.81	2	56.91	38.73	<.0001	6.8
PxT	409.31	188	2.18	1.48	.0008	24.3
PxI	146.87	94	1.56	1.06	.3477	8.7
TxI	79.02	8	9.88	6.72	<.0001	4.7
PxTxI	552.45	376	1.47			32.8

NOTE: The PxTxI interaction was used as the error term in computing each *F* value. This procedure was also employed by Stewart, et al. (1969).

conservative degrees of freedom. However, because this interaction has now been demonstrated in three separate samples of platoons (counting the Stewart, et al. (1) findings), it is reasonable to assume that it exists. The average proportion of variance accounted for by this interaction was substantial in our two samples of platoons (29.1 percent). By contrast, the average proportion of variance accounted for by Platoon was 8.7 percent. The interaction was marginally significant despite accounting for a large proportion of variance because the interaction computations involved a large number of degrees of freedom.

A "Platoon by Illness' ANOVA was performed for each training period to replicate the Stewart, et al. (1) finding of increasingly significant differences between platoons as training progressed. This analysis also represents an examination of the "simple effects" of platoon differences that contributed to the Platoon by Time interaction considered above (see reference 9 for discussion of simple effects). Examining these simple effects provides an opportunity to determine whether the Platoon by Time interaction represents comparable patterns of illness variation in the two samples of platoons. If not, the interactions do not replicate one another. The results showed that the two samples of platoons in this study showed a comparable pattern of illness during training. This pattern only partially replicated Stewart, et al.'s (1) observation of increasing platoon differences throughout training. Platoon differences were initially nonsignificant, but achieved significance during the third training period (Sample 1, $F = 2.85$, $p<.001$, conservative $p<.198$; Sample 2, $F = 1.71$, $p<.011$, conservative $p<.105$; combined probability, $p<.001$, conservative $p<.098$). The differences became somewhat more significant during the fourth training period (Sample 1, $F = 3.92$, $p<.001$; conservative $p<.056$; Sample 2, $F = 1.88$, $p<.005$, conservative $p<.177$; combined probability, $p<.001$, conservative $p<.056$). This trend did not continue into the last period of training as it did for Stewart et al. (1).

Table 3

Correlation of Incidence Rates for Different Types of Illness

		URI	Trauma	Other
Overall Rate	URI	---	.20	.51**
	Trauma	.37**	---	.26
	Other	.14	.06	---
Period 3 Rate	URI	---	.44**	.38**
	Trauma	.26	---	.34**
	Other	.19	.18	---
Period 4 Rate	URI	---	.65**	.39**
	Trauma	.25	---	.45**
	Other	.19	.25	---

NOTE: Entries below the diagonal are for Sample 1 (N = 34). Entries above the diagonal are for Sample 2 (N = 48). The correlations for the rates for Periods 1, 2, and 5 are not shown because the combined correlations were not significant for those periods (see text).

*$p<.05$

**$p<.01$

Correlations between illness incidence rates provided mixed support for the emergent social climate hypothesis. As previously observed by Stewart, et al. (1), illness rates for different diagnostic categories were correlated (see Table 3). For the overall illness rates, the combined probabilities of the observed correlations were $p<.009$ for URI-Trauma, $p<.015$ for URI-Other, and $p<.108$ for Trauma-Other. The emergent social climate hypothesis led to the prediction that correlations between incidence rates would be higher during the later parts of training. Some support for this hypothesis was provided by the correlations for the third and fourth periods. For the third period, the combined URI-Trauma correlations were significant ($p<.002$) as were the URI-Other correlations ($p<.009$) and the Trauma-Other correlations ($p<.019$). For the fourth period, the comparable figures were $p<.001$, $p<.009$, and $p<.002$, respectively. This trend toward more pronounced correlations during the later training periods did not extend to the last period.

A second hypothesis derived from the emergent social climate hypothesis was that correlations between illness incidence rates for adjacent time periods would increase as training progressed. The only evidence of stable platoon differences were found for URI from period 1 to period 2 (Sample 1, $r = .26$, $p<.006$; Sample 2, $r = .22$, $p<.067$; combined probability, $p<.009$) and for "Other" illness from period 2 to period 3 (Sample 1, $r = .25$, $p<.074$; Sample 2, $r = .17$, $p<.125$; combined probability, $p<.020$). Total illness incidence rates were significantly related between periods 1 and 2 (Sample 1, $r = 16$, $p<.181$; Sample 2, $r = .24$, $p<.050$; combined probability, $p<.027$). Clearly the correlations were only marginally significant and did not show a trend toward stronger associations for the later training periods.

A final analysis examined the relationship between illness incidence rates and the number of incidents that did not require restricted duty status. The present analysis replicated the Stewart, et al. (1) findings of slight correlations (Sample 1, $r = -.02$; Sample 2, $r = -.17$). When the same correlation was computed for the separate phases of training, the only evidence of an association was the trend in the fourth period (Sample 1, $r = .36$, $p<.034$; Sample 2, $r = .12$, $p<.418$ combined probability, $p<.043$). A final ANOVA established that the porportion of incidents requiring no restriction of duty did not differ between platoons, thereby replicating another Stewart, et al. (1) finding.

DISCUSSION

Stewart et al.'s (1) postulation of an emergent general factor affecting illness in basic training was based on three findings: (a) Significant platoon differences in overall illness rates. (b) increasing significance of these differences as training progressed. (c) A significant correlation between illness rates into two broad, but distinct, categories of diagnosis. The present data replicated the finding of platoon differences in overall illness rates. To date, these differences have accounted for 8 to 10 percent of the overall variation in illness rates in basic training. The significance of the platoon differences increased up to the fourth period of training, then decreased during the last period. The contrast between this and the Stewart, et al. (1) observation of a continuing increase could be due to methodological factors (e.g., a longer training cycle and corrections for differences in platoon size in the present study). Finally, the data confirmed the presence of correlations between illness rates in different diagnostic categories. At this point, a reasonable conclusion is that such correlations truly exist, but are moderate in magnitude. These associations imply the presence of some general factor or factors affecting illness in basic training which have a modest overall impact on illness rates.

Additional analyses tested two hypotheses based on the assumption that whatever general factors influenced illness rates developed during the course of training. It was predicted that: (a) Illness rates for different

diagnostic categories would become more highly correlated as training progressed. (b) Platoon differences in illness rates would become stable characteristics of the platoons as training progressed. The latter hypothesis predicted increasing correlations between illness rates for adjacent training periods over the course of training. The first hypothesis was supported up to the last training period. The second hypothesis was not supported.

Meaningful interpretation of the results must take into account several considerations. First, in terms of overall variation in illness rates, the effects of any general factor(s) are modest. This point is indicated by the fact that the platoon differences in illness rates account for less than 9 percent of the total variation in overall illness rates and by the moderate correlations between illness rates for different diagnostic categories. An implication of this observation is that any single "general factor," e.g., social climate, will account for less than 9 percent of the variation in overall illness rates. This follows from the fact that the platoon differences set an upper limit on the impact of any "general factor" or set of general factors and from the fact that there are almost certainly a variety of differences between platoons that affect illness rates. Any single factor may account for as little as 1 or 2 percent of the total variation in illness rates over the entire training period. During specific portions of training, however, these effects may be stronger as discussed below.

Other considerations may explain why stable platoon differences in illness rates did not develop. An implicit assumption for this hypothesis was that any "emergent general factor" was stable once it developed. This may not be true. For example, recent evidence suggests that social climate changes throughout training (10). Part of the reason for this change may be that general factor developments proceed at different rates in different platoons. If so, factors that are stable once fully developed can show varying patterns of platoon differences throughout training. Another point is that even a stable "general factor" does not guarantee stable platoon differences in illness rates. A URI epidemic or performing a training exercise under weather conditions that increase the risk of minor injuries could markedly alter platoon illness rates within a given training period. Differential exposure of individual platoons to such factors could mask the effects of even a fully developed, stable "emergent general factor," particularly if that factor had the modest effects noted above. Given these facts, the absence of stable platoon differences in illness rates is not strong evidence that general factors such as social climate do not affect illness in training.

Further consideration of this last point provides a possible explanation for the failure to observe more significant platoon differences and stronger correlations between illness rates for different diagnostic categories during the last training period. The predicted trends would be expected given "all other things equal." However, during the last period of training there are increased physical demands (other than hiking) and increased drill practice. Both changes are in preparation for examinations which are taken very seriously by the recruits and their Drill Instructors. These changes increase the risk of stress fractures, strains, sprains, and other minor traumas. Similar factors operate during the initial training period with perhaps even more pronounced effects since recruits are initially less fit (11). At that time, recruits are also exposed to novel pathogens which may contribute to infectious disease (12). Note also that the task demands inherent in test preparations and other aspects of the training program during these periods may minimize platoon differences for general factors such as social climate. The contributions of these task variations may mask the effects of general factors in both the early and later periods of training.

The net result of the above considerations is that a modified version of the general factor hypothesis fits the data available to date: General factors such as social climate in basic training have a modest, but potentially important, effect on illness which is clearly evident only when other causes of illness are relatively inactive. This conditional formulation of the "general factor" hypothesis is consistent with the main trends of the data including (a) evidence of a weak general effect and (b) higher significance of platoon differences with stronger correlations between illness rates for different diagnostic categories during the third and fourth periods of training

when (c) the overall illness rates were relatively low. The lower illness rates at the time of primary expression for the general effects would be expected if such effects are best observed when other illness causes are relatively inactive. This expectation underscores the moderate magnitude of the general factor effects because only moderate effects could be readily masked. The revised hypothesis does not assume that general factors are "emergent." The temporal trends which led Stewart, et al. (1) to suggest this attribute could be due to methological factors or the effects of other causes of illness masking the early effects of the general factor.

Overall, the basic observations that led to the suggestion of a general factor influencing health in basic training were replicated in this study. More detailed examination of the trends in our two samples of platoons led to the revision of the general factor hypothesis suggested above. Because the differences between the present study and the findings by Stewart et al. (1) are minor relative to the similarity of the findings in the two studies, it appears reasonable to assume that some general factor or factors affect health in basic training. Future research should incorporate the points noted in the discussion of the present results into research designs which would isolate general factors, estimate their effects, and determine the temporal trend of those effects. On the basis of the evidence available to date, the general factors would be expected to have moderate, but potentially important, effects.

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Injury/Trauma	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Previous observations of differences in illness rates among Marine Corps basic training platoons suggested that a general factor such as emergent social climate within the platoons might affect these rates. This conclusion has potentially important epidemiological implications, but the findings may have been influenced by methodological factors in the initial research. The present study attempted to replicate the earlier findings with procedural

20. Abstract (continued)

modifications intended to reduce the possible impact of methods factors. Data were recorded from the health records of recruits in two samples of platoons. Analysis of variance indicated that overall illness incidence was significantly related to platoon, period of training, type of illness, and an interaction between platoon and period of training. Illness incidence rates in different diagnostic categories tended to be correlated suggesting the effect of a general factor. This correlation was limited primarily to two periods late in the training cycle. Therefore, while the overall results replicated the major findings of the earlier study, the conclusion was modified. A general factor such as platoon climate may affect illness, but possibly only at points in the training cycle where more traditional factors such as pathogen exposure and unusual physical exertion are not major considerations.